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Incorporating Health impacts from Exposure to Chemicals in Food Packaging in Life Cycle Assessment

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Background and Scope

In food or food packaging related LCA studies, human health impacts are typically evaluated by considering substance emissions, environmental fate, and subsequent population-scale intake of contaminated air, drinking water, and food (fish, meat, etc.). Exposures to chemicals migrating from packaging into food products are neglected, although increasing evidence suggests human exposure to chemicals occurs mainly through diet, and is partly attributable to chemicals used within packaging (Muncke et al., 2014, doi:10.1136/jech-2013-202593). Of particular interest are therefore LCA studies investigating impacts of food and beverage packaging materials which have found benefits to plastic-based materials when compared to glass. The outcome of such studies may be affected with regards to human health impacts, if migration of chemicals, such as endocrine disruptors, from plastic packaging materials into food products is considered. To allow for consistent comparison of different exposure pathways for food packaging chemicals, we present a framework to account for exposure from both environmental emissions and direct food contact (Figure 1).

Framework

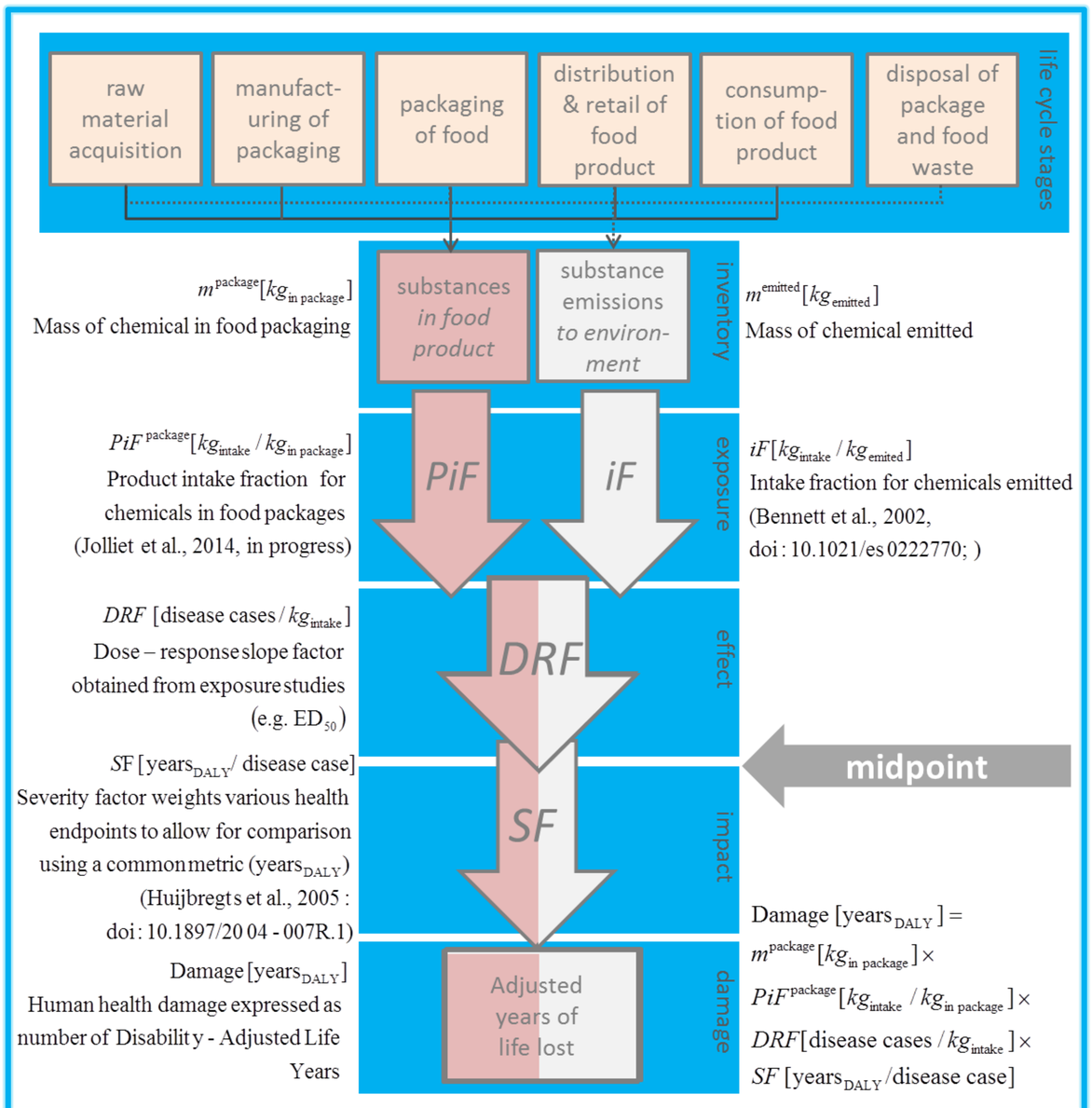

Figure 1. General LCIA framework for substance intake due to food packaging where both *PiF* and *iF* may be combined with toxicity information to estimate the common endpoint of population-scale human health damage

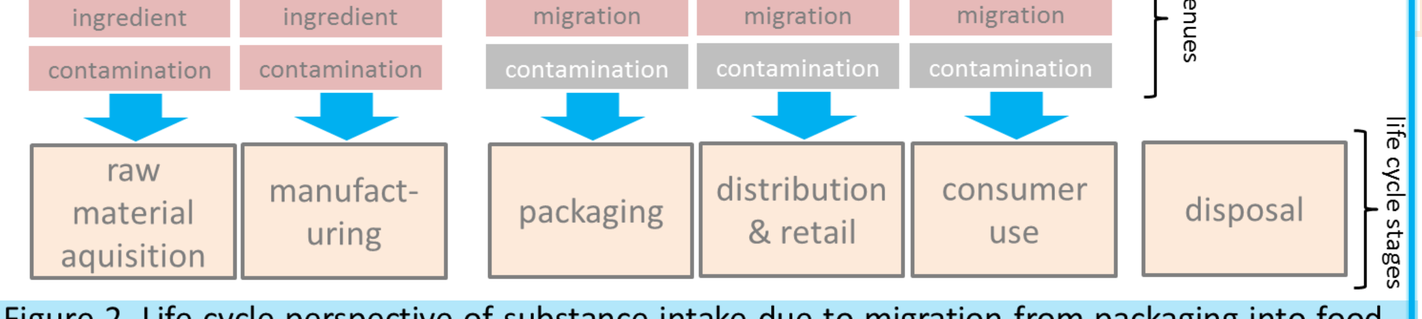

Figure 2. Life cycle perspective of substance intake due to migration from packaging into food products where chemicals may enter a food package and subsequently a food product through various avenues during the food packaging's life cycle, such as: a reaction (e.g. residuals from an incomplete chemical reaction), an ingredient, or a contaminant (background environmental contamination), (grey shaded avenues are assumed less likely)

Methods and exploratory work

Preliminary work suggests at the midpoint level a human toxicity indicator (e.g. disease cases/kg intake) could be based on the substance inventory due to migration from packaging into food. There is a subset of migration data available through DTU Food and an open-access model, FACET, newly released by the European Commission. The end-point level, e.g. an aggregated human health damage ($years_{DALY}$), may be calculated from midpoint using existing LCIA methods (figure 1). As inventory investigation the Chemical and Product Categories, CPCat (http://actor.epa.gov/cpcat/) database of the US EPA was screened for food packaging chemicals and compared to chemical lists containing toxicity information, such as regulatory lists and the substance data from USEtox®.

Results

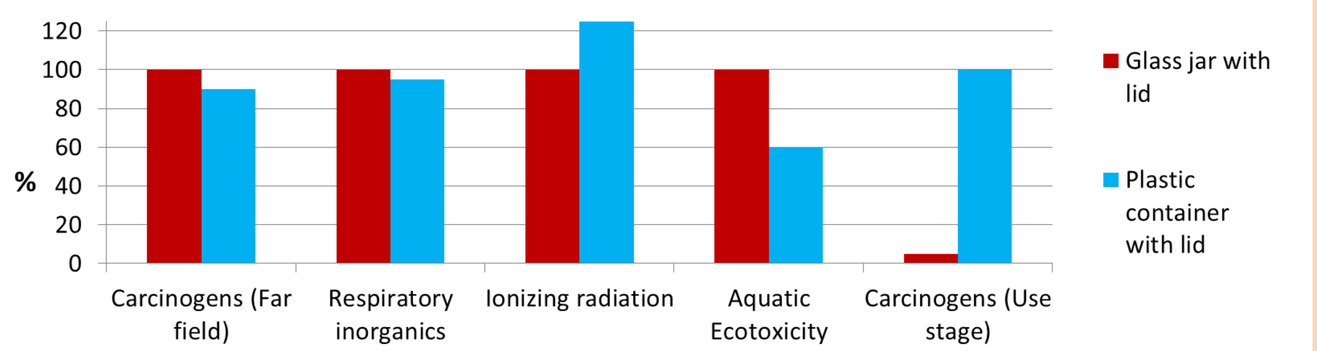

Figure 3. Example impact indicator results at midpoint level for glass versus plastic packaging where the use stage chemical exposure to a glass package with a lid and gasket is assumed to be <5% of the chemical exposure due to plastic packaging (assuming glass is inert and migration due to chemicals within lid or gasket is minimal). Results for the first 4 categories adapted from: "*Life cycle assessment of two baby food packaging alternatives: glass jars vs. plastic pots*" **Humbert et al. 2009, doi:10.1007/s11367-008-0052-6**)

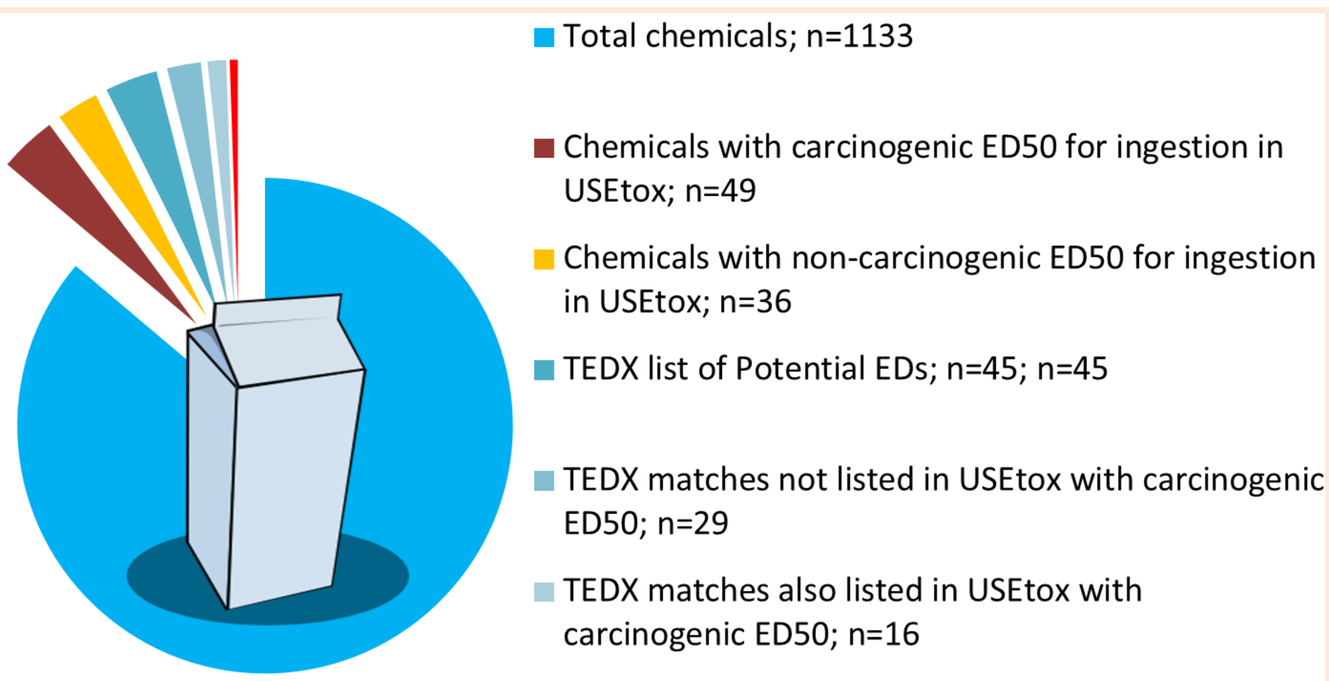

Figure 4. Chemicals related to food packaging according to the CPCat database and connection with chemical lists containing toxicological information where ED50 refers to the estimated lifetime dose affecting 50% of an exposed population, and ED refers to endocrine disruptors

Conclusions

A framework was developed to incorporate use stage chemical exposures, in this case human exposures from eating a packaged food, into LCIA. The previously reported comparative benefit of plastic versus glass packaging could be offset by damages associated with use stage exposures to chemicals within plastic packaging. Requiring further investigation, 50 food packaging chemicals were found to be potential endocrine disruptors, a class of chemicals for which methods to identify them and evaluate their toxicity are under development in the U.S. and EU. These chemicals pose a particular challenge due to their likely non-linear dose-response functions as well as potential additive effects.

Acknowledgements

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